PRODUCTION MANAGER

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PAGE 6 IN YOUR PLASKON COATING-RESIN PRODUCT DIRECTORY

PLASKON 3121

SHORT DEHYDRATED CASTOR OIL ALKYD SOLUTION

for beauty and durability in metal baking primer and surfacer applications...

PLASKON 3121 is a short dehydrated castor oil alkyd in a high boiling petroleum aromatic solvent and butanol. It is similar in composition to Plaskon 3120 with the exception of solvents. PLASKON 3121 is designed to be used to the best advantage in roller coating metal-decorating finishes where the control of solvent evaporation is critical. PLASKON 3121 may be used alone but is most useful when formulated with urea and melamine resins. Like Plaskon 3120, baked films of such formulations have outstanding color retention and gloss, excellent adhesion and toughness, and unusually good resistance to exterior exposure.

PLASKON 3121 is recommended for industrial baking primers and finishes for venetian blinds, metal signs and tiles, can coatings, and many other metal applications.

TYPICAL CHARACTERISTICS

SOLUTION

Solids (%)	50±1
Solvent (%)	Solvesso 150, 42.0, Butanol, 8.0
Color (I.P. & V.R.)	Under 5
Acid Number	Under 4
Viscosity (G.H.)	Z-Z_2
Solids (%) @ Vis. C-E	35
Pounds per Gallon	8.36

SOLIDS

Phthalic Anhydride (%)	39
Oil (%)	37
Oil (Type)	Dehydrated Castor
Rosin	None
Phenolic Resin	None
Specific Gravity	1.20

The Plaskon line of coating resins includes Pure Alkyds—Modified Alkyds—Ureas—Melamines—Modified Phenolics—Maleics—Ester Gums—Pure Phenolics.

We invite correspondence regarding your need for Plaskon* Coating Resins in the paint, varnish and lacquer industries.

*Reg. U. S. Pat. Off.

PLASKON
TRADE MARK REGISTERED
COATING RESINS

PLASKON DIVISION
LIBBEY·OWENS·FORD GLASS CO.
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PAINT and VARNISH PRODUCTION MANAGER
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COLD-HARDENING VARNISHES

By DR. ERICH KARSTEN

The very limited supply of natural fatty oils and natural resins in a number of European states has for the last 20 years led to the development of numerous synthetic, or artificial, raw materials for the production of paints and varnishes which in contrast to the first products of this type cannot be considered cheap substitutes or surrogates anymore. Indeed, many of these products have gradually been developed to a state of perfection enabling them to compete successfully with the natural raw materials even where the latter are obtainable in abundance.

Chemical research going hand in hand with this development has been advanced to a point where definite conclusions can be drawn with regard to the chemical constitution and structure of ideal synthetic vehicles and to the chemical configurations best suited to any one of the practical requirements made upon the products. A very considerable help in this direction have been the large-scale technical research operations in connection with the development of the caoutchouc synthesis. The development of all the paint vehicles such as the polyvinyles, Ingewines, Movilithes, Acronales, Plexigum-materials, a.s.o., which owe their creation to the reactivity of the so-called vinyl group $CH_2{=}CH$, is the result of the experience gained in connection with the large-scale syntheses mentioned. There can be no doubt, however, that the immense research and practical work toward the development of the phenol and urea resins during the last 10 or 12 years have also been extremely successful in this direction.

These new phenol and urea resins form the basis of the so-called cold-hardening varnishes, which were first used almost exclusively for the treatment of wooden surfaces but which have lately been applied successfully to the treatment of metallic surfaces as well.

The term "cold-hardening" in itself points toward two characteristics of these paint materials, first, that they can be worked in the cold, i.e., at low normal temperatures and that after application and drying their films undergo a process of pronounced hardening at room temperatures. The possibility of working these varnishes in the cold—without the necessity of applying elevated temperatures—offers them a very wide range of application, especially in view of the fact that they can be applied by brushing as well as by spraying. The changes of their films due to natural ageing distinguishes those materials in a most advantageous manner from the films of the common resin solutions.

Chemically speaking, the cold-hardening varnishes contain phenol- or urea-formaldehyde resins, producing films of special properties under the influence of acid admixtures in the cold.

If a resin, such as—for instance—a synthetic copal, resin ester or cumarone resin is dissolved in some suitable solvent, such as an oil of turpentine substitute and the solutions is brushed onto glass, a hard, brittle and soluble film is formed which, however, does not exhibit any special characteristics, let alone advantages over other materials of this type. It appears illogical, on the other hand, to condemn this reversible film formation, i.e., the continuously soluble film. It should be remembered that the films of nitrocellulose lacquers remain soluble as well, and there can hardly be any doubt as to the technical value of these materials. Nevertheless, there can be no doubt that films undergoing certain changes after application and drying, rendering them

gradually insoluble, appear to be the most ideal.

Films of this type are produced by the oil- or alkyde resin varnishes as well as by all those types of varnishes which on stoving form insoluble films of maximum mechanical strength and chemical resistance.

Resins of this latter type are the phenol- and urea-formaldehyde resins. The former have partly become known as Bakelite varnishes. The exceptional technical properties of the phenol resin films stoved for one hour at temperatures of 180-200 degrees Centigrade or those of the urea resin films stoved at somewhat lower temperatures have naturally created a pronounced demand for a variation of these resins in such a way as to obtain the same technical characteristics on drying at ordinary atmospheric temperatures.

It has been known for a long time that many phenol-formaldehyde resins if present in thin layers tend to form films of unusual qualities (if compared to ordinary resin films) under the influence of acids or, partly, of alkaline substances. It is true that the first products of this type exhibited a number of serious disadvantages, chiefly faulty film formation such as pits, pores, faulty spreading, etc., but it has been possible during the last decade to regulate the film-forming processes in such a way that practically all these faults have been eliminated. It has also been possible by improving the composition of the varnishes to eliminate from the two types of resin their tendency toward initial embrittlement and the corresponding deterioration of the films due to lack of elasticity.

The plastification of the phenol- and urea resins was a very important factor since the ordinary plastifying agents in connection with these resins do not always yield the results to be expected from the percentages of plastifiers added to the varnishes. It is true that not all plastifiers yield similar results in this direction, even in the case of stoved phenol resins. Some of the latter, such as tricresyl-phosphate, produce effects corresponding to those of real plastifiers while others can be compared only with ordinary cutting agents as far as their stoving effects are concerned, without yielding the desired improvements of the mechanical properties of the stoved films. It is well known, of course, that by lowering the stoving temperatures of these substances their general influence is improved, while on addition of plastifiers to non-hardening phenol-resins, the so-called Novo-lacquers, the plastifying effect corresponds to the percentual addition of these substances. In the case of the cold-hardening vehicles on a phenol- or urea basis the addition of suitable plastifiers will produce a certain degree of elasticity at least during the initial stages of film formation and previous to complete ageing of the films.

However, if these resins were able to form films exhibiting certain improvements concerning the elasticity, adhesion and wearing, or rubbing, resistance in contrast to colophony or Manila-copal varnishes, they would doubtlessly be useful for a number of purposes.

It is a typical characteristic of linseed oil to induce by the absorption of atmospheric oxygen a solid film with modified solubilities and structures, and similar conditions prevail in the case of the phenol and urea resins, or in the varnishes produced by them, in which the action of suitable acid substances causes the formation of solid films exhibiting modified properties in contrast to the original substances.

If this process is studied from a physico-chemical point of view, we note that the comparatively small molecules characterizing the initial state of the resins are changed by chain-formation or netting into considerably larger resin film molecules —parallel to the film-formation of linseed oil resins. Prof. A. Eibner characterized this process as a colloidal process induced by chemical causes.

The handening process by means of acid substances develops as follows:

In order to make conditions entirely clear it appears advisable in the first place to describe the original method of treating the phenol-formaldehyde resins or the urea-formaldehyde resins and their varnishes. The solutions of these resins in volatile solvent mixtures are applied to metallic surfaces which in the case of the phenol resin mixtures are then stoved for 30 to 60 minutes at temperatures of from 180 to 220 degrees Centigrade, while the urea resin varnishes usually require lower temperatures, such as 120 degrees Centigrade (for 1 hour). The stoved phenol resin varnishes exhibit a strongly yellowed color, while the urea resin films remain absolutely colorless and clear; indeed, they remain colorless even if the stoving temperatures are raised to 170 degrees Centigrade. In any case, the stoving temperatures of all these resins, or varnishes respectively, are located above 100 degrees Centigrade. These relatively high drying temperatures in connection with the internal process of film formation induced by the enlargement of the molecules is accompanied by the release of water from the drying and solidifying film. This reaction which also takes place in the production of synthetic resin products for other purposes, is termed "Condensation" by the chemist, and if the final product of this condensation process is the chemically

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SUBJECT INDEX

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inert and mechanically resistant phenol- or urea resin film, the importance of this reaction becomes self evident.

It is quite obvious that in the case of the cold-hardening process (placing emphasis on the term "cold") this condensation reaction takes place in a much lesser degree, if at all, so that the growth of the molecules can be due only to much less energetic reactions, or influences, and it must therefore be supposed that the technical effects of the reactions taking place in the cold cannot attain the degree of those induced by the drying processes at elevated temperatures.

An approximate idea of the growth and the kind of film constituents on basis of their degree of solubility can be obtained by several methods, for instance, by extracting the films with boiling alcohol. It need hardly be mentioned, of course, that the solvent power of boiling alcohol is entirely different from that of cold alcohol. An experiment of this kind with a phenol resin film and an urea resin film yielded the following results:

Extraction of phenol- and urea resin films with boiling alcohol

	Phenol resin	urea resin		
Stoved 1 hr. at 110°C	69%	45%	soluble	constituents
Stoved 1 hr. at 180°C	1%	4%	"	"
Cold - hardened with hydrochloric acid				
after ageing for 14 days	100%	100%	"	"
after ageing for 14 months	55%	70%	"	"
after ageing for 27 months	37%	36%	"	"

The table indicates that the degree of insolubility of the phenol- and urea resin films attained after only 1 hour of stoving at 180 degrees Centigrade has not been reached by the cold-hardening films even after 2¼ years of cold drying. This refers to the soluble constituents of these films, while the differences between these films regarding the film-forming processes proper and the physico-chemical structure of the films are doubtlessly still more pronounced.

It is thus evident that films hardened with acid substances represent a product entirely different from films made of exactly the same varnishes but dried in the absence of acid by stoving at temperatures of above 100 degrees Centigrade. Nevertheless, the fact that cold-hardened varnish films contain a considerable percentage of substance insoluble in boiling alcohol proves that this type of film formation points out a useful way leading to a more or less perfect method of synthesis of varnish vehicles.

As to the action of the acid within the film-forming substance, nothing definite can be stated at this present moment since the results of the various experimental investigations have not cleared up all the problems surrounding the reactions in question. As to the amount of acid substances to be added, the age-old saying "much does much" must be applied with limitations—exactly as in the case of the siccative additions. The various hardeners in question exert different effects in the same manner that—for instance—lead siccatives differ considerable from the cobalt siccatives.

The practical varnish producer naturally is most interested in the possible methods of producing and working these new cold-hardening varnishes. In most instances the pigment or varnish materials—whose vehicles consist partly or wholly of phenol- or urea-formaldehyde resins or their mixtures—and the hardeners are supplied separate. The hardeners represent more or less concentrated solutions of an organic or inorganic acid in various organic solvents. Acids used for this purpose may be hydrochloric acid, phosphoric acid, oxalic acid, and so on. These acid substances are only added shortly before the application of the varnishes in certain definite proportions depending on conditions and in accordance with specification, for instance, 1 part of hardener and 9 parts of paint or 1 part of hardener and 4 parts of varnish.

The question now arises why the hardener must be added directly previous to application and why the finished mixture cannot be left to stand for more than one or a few days before application. This is due to the fact that the hardening process commences rather quickly after addition of the hardener and that the viscosity of the mixture increases so rapidly that after a comparatively short time the varnish commences to gelatinize. This rapid action can of course be retarded by the addition of thinners but cannot be stopped entirely.

A most recent feature of this development is the addition of certain smaller amounts of hardener to the varnish during the production stage, although for the reasons indicated above the quantities added are not nearly as large as those used when adding the hardeners directly previous to application. These cold-hardening varnishes can be stored for a considerable time previous to usage and possess the advantage of rendering the product ready for direct application, i.e., after adding a few percent of thinner. All weighing and measuring is thereby eliminated. These cold-hardening varnishes containing relatively small amounts of hardeners appear to be particularly useful for application to metallic surfaces, since only a very small percentage of the total quantity of acid in the varnish (which in itself is not very considerable) gets into actual touch with the metal, that is to say, only those acid particles which happen to be located between the metal surface proper and the varnish film. In view of the fact that as a rule a large proportion of the hardener consists of phosphoric acid there can be no doubt that the acid constituents of these varnishes hardly exert any pronounced corrosive action on metallic surfaces.

It is possible to use these vehicles with all types of paints such as priming paints, enamels, filling substances, clear varnishes, etc. A very important factor is that wood, which—as is well known—represents a very difficult base material, reacts very favorable with the cold-hardening varnishes, very much more favorable in any case than could possibly be expected of a paint material entirely free of fats.

The cold-hardening paints and varnishes can be easily applied by brushing. In spite of its consistency, the material does not give the feeling of viscosity. The varnishes can, of course, be sprayed, while the dipping processes may be carried out only under certain favorable conditions of application, since on account of the size of the dipping bathes required and of the danger of gelatinization involved these processes are usually carried out only with difficulty.

Drying of the films proceeds comparatively quickly. The films of cold-drying paints and varnishes are surface-dry after a few hours and can be brushed or sprayed over after six hours and are entirely dried through after about 12 to 18 hours (next morning), depending on general atmospheric conditions. After a few days the films of cold-drying enamels and clear varnishes can be polished to high gloss.

A very important advancement in the application of cold-drying paint and varnish materials of modern manufacture is that subsequent warming to 50-100 degrees Centigrade will improve the technical properties of the films considerably. Indeed, it has been found that under suitable conditions the properties of these heat treated cold-drying films do not differ materially from those attained with standard stoving paints and varnishes. This possibility is of greatest value to a number of industries, such as—for instance—the metal industry producing complicated parts for technical and scientific apparatuses. If these parts have to be stoved at temperatures of up to 200 degrees Centigrade, they frequently are bound to suffer from warping, or distortion, while the subsequent drying temperatures of cold-hardened paint or varnish films rarely exert this influence on even the most complicated metallic sections.

TECHNOLOGY

LACQUER FOR MOISTUREPROOF COATINGS. German Patent 724,144. Kalle & Co. Applied for Jan. 1, 1928 (applied for in U. S. Jan. 3, 1927); granted Aug. 19, 1942. A clear, drying lacquer for the production of coatings which are impermeable to the moisture in air, consist of 30 to 70 parts of a cellulose derivative (e. g. cellulose nitrate, cellulose acetate, ethyl cellulose), 30 to 60 parts of a resin (e. g. dammar, mastic, copal) to bind the cellulose derivative and the paraffin, 2 to 6 parts of a high-melting paraffin, and 5 to 30 parts of a softener (e. g. tricresyl phosphate, triphenyl phosphate, diamyl phthalate, dibutyl phthalate or castor oil).

THE FACTORS AFFECTING GRINDING EFFICIENCY IN BALL AND PEBBLE MILLS

By THE BALTIMORE CLUB*

The underlying motive in selecting this work is mainly the dissatisfaction developing in this industry. This dissatisfaction is with the manufacturers of grinding equipment made available to the paint and allied industries. In the early 30's most of you can remember the efforts made to manufacture uniform alkyd resins in equipment that was then available, and the sorry results obtained. It took about five years of non-uniform resin manufacture to awaken the technical men. They then sat down and designed their own equipment. Such a situation is comparable to grinding equipment made available today. It has been for many years. Our industry knows very little about the dispersing of pigments. There certainly is plenty for us to learn when the same pigment can be dispersed in four different types of equipment, ranging in grinding time from two hours to seventy-two hours. These four types of equipment are the pebble mill, the ball mill, the roll mill, and the dough mixer. Our paper deals today with the pebble mill—at that we only brush the surface, and this work is only an introduction to work yet to be done in the future.

We did not delve into ancient history to determine when closed mills were first used in the paint industry. Up to the last twenty years many pigments not only had to be dispersed, but had to be ground by friction to obtain particle size as well as dispersion. In recent years pigments have been made available which require just normal, simple dispersal. Actually, it is a problem of proper wetting, since flocculation and agglomeration contribute to the appearance of poor grind. Many practices have been evolved in obtaining good yield in closed mill grinding; however, many of the operators of closed mills can tell a good anecdote relating to their first experience with closed mills, such as filling the mill up with material and letting it run until acceptable fineness is obtained. This could be anywhere from four days to four weeks. Some people put pebbles in half-way up from the floor of the mill and grind and grind in an overloaded mill and then complain of poor dispersion. Some self-made paint plant engineers build steel balls mills. One such incident very familiar to the writer occurred a few years ago. After three weeks of lining up and mounting an old boiler, this homemade mill was finally charged. After three days of operation a series of terrible noises startled everyone in the neighborhood when the mill wore through from the friction of the hard steel balls on the soft steel boiler.

This work is divided into three phases. First, the laboratory method used in developing proper charging of so-called one gallon pebble mills, wherein a series of laboratory grinds were run arbitrarily, using 3/4 inch flint pebbles to determine at what viscosity adequate cascading occurs. This was determined to be between 85 and 90 Krebs Units—using the control formula which from experience indicated no increase in viscosity on grinding—also containing adequate driers, yet possessing good package stability for testing. The control formula, while not designed to be a finished paint, actually results—when properly ground—in a high hiding, low gloss enamel. It is composed of the New Jersey Zinc Company's Zinc Sulphide, which requires grinding to develop good hiding, color, and texture. The vehicle was a 20 gallon cold mixture of low acid Ester Gum Solution and Z Linseed Oil, plus driers and Mineral Spirits to yield a viscosity of 90 Krebs Units.

A series of experiments were run by six opertors, three of whom used 3/4 inch porox and the other three used 3/4 inch flint. This was done to check the results on the control formula. In all respects the flint grinds at thirty-six hours were equal to porox grinds at 48 hours. The charge on this first series was as close to conventional procedure as possible; that is, the pebble mill filled half-full with pebbles and then charged to about 1/2 inch over the level of the pebbles. Calculation was made on this charge and it resulted as follows —that the pebble volume displacement equals 1 and the charge equals .93. Reverting back to the original charge, there were 3,600 grams of pebbles and 2,400 grams of paint. With this series of results on hand, a second series was run to determine if better yields could be obtained by varying the charge to the pebble displacement. This series was run at 1 to .63, 1 to .78, and 1 to 1.1. In no case did the lower or higher charges indicate better yield over the same grinding time than the control formula. The same results were obtained using porcelain balls; that is, the control formula yielded equal to or better than any of the other variations in charge.

To translate this series of work into simple language—both for the laboratory and plant—each size mill, of course, requiring a different ratio because of variables such as diameter of the mill, type of lining, size of the mill, and the R.P.M. of the mill, as well as the type of charge. There is no question that while most of us charge a laboratory mill by filling it half full of pebbles and charging it with a batch slightly over the level of the pebbles, reasonable accuracy in charging is obtained. However, this work ties the ratio of charge to grinding medium displacement to a positive charge for each mill individually. While best

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*This paper was presented by M. E. Carson at the annual convention of the Paint and Varnish Production Clubs in Chicago, Ill., November 1948.

results were obtained on the control grind at 1 to .93, a series of experiments were run in the plant in a fifty gallon total capacity mill containing three inch porcelain balls. It was charged with the control formula, less Mineral Spirits, and one part grinding medium by volume to .8 parts by volume of mass, at 1 to 1, 1 to 1.2, and 1 to 1.4, using the same system as was used in the laboratory—allowing the higher viscosity because of the size of the porcelain balls, the diameter of the mill, and the 32 R.P.M. as compared to the average 60 R.P.M. on the one-gallon laboratory mill.

The results were as follows on 24 hour examination of each grind. At 1 to .8—very poor. It did not appear to be the grind, but rather splintering and general wear from friction of the porcelain balls to the lining. This batch while grinding was unusually noisy. At 1 to 1 results were fair. This batch was also somewhat noisy. At 1 to 1.2 very good results were obtained. While grinding, this batch indicated soft, positive cascading. At 1 to 1.4 fair results were obtained—given an additional six hours it matched the results of the 1.2 charge. However, this charge again was somewhat noisy, and noise indicates excessive friction of the grinding medium to lining, and again you run the risk of poor grind because of the splintering and excessive friction.

The question always arises what size pebbles should be used. This can be anywhere from 3/4 inch in diameter up to three or four inches. This choice is dependent upon several factors:

1. The diameter of the mill.

2. The R.P.M. of the mill.

3. The type of lining and the grinding medium.

4. The type of charge. Is it a high vehicle solids low pigment charge, or is it a low vehicle solids high pigment charge? Assume that we have two porcelain lined mills of equal size running at the same speed, and the grinding medium is up to the 45% level in the uncharged mill. This—most of us will agree—is good practice. At high vehicle solids low pigment lead, acceptable grind is obtained in thirty-six hours from one mill, using very large pebbles. In the other mill we charge the same total volume, consisting of approximately 25% more pigment, and the vehicle composition of 90% thinner and 10% vehicle solids. An acceptable grind can be obtained in as little as four hours, but rarely requires more than eight hours. The above comment brings us to the basis of a great deal of work yet to be done by all of us.

Technical Committee

The Technical Committee of the Baltimore Paint and Varnish Production Club consists of Leonard Schaeffer, Howard Goetz, A. W. Lynch, A. J. Bruning, J. D. Prince, Irwin Baker and Francis Scofield.

FUNCTIONAL USE OF LACQUER

By GEORGE A. MOORE, Vice President, Reynolds Metals Co., Inc.

Lacquer is a mighty broad term because the word embraces so many base materials into which countless formulations are concocted, to serve a given purpose. The opportunity for discovery of new base materials, as well as their basic treatment for useful applications has never been more inviting.

I call to mind a secret test made for the Navy which I feel can now be revealed. A new resinous compound (name referred to later) was used to paint one of the Navy planes that had to be stepped up for climing ability; it glistened in the sun, shining like a huge diamond. Air drag was nil—down the runway it shot like a rocket and in a remarkably short distance the plane was in the air, climbing at fantastic speed. The pilot noticed his throttle was only 1/4 open, he advanced to 1/2 open, then 1/8 more and took his readings. He was startled into wild excitement at his terrific speed and altitude, then he threw the throttle wide open, looked at his instruments, noticed his speed had advanced to 1800 mi. per hour and his altimeter had burst.

Let us begin by looking at a perspective of lacquer function possibilities:

1. To give gloss over surface of web materials.
2. To give slip to web materials to facilitate handling.
3. To prime surfaces for further processing.
4. To bond materials together as an adhesive.
5. To protect printing inks, safeguarding against scuffing and, at the same time, add richness to color values.
6. To serve as a vehicle for printing inks, coloring dyes and pigments.
7. To serve as a thermo-plastic dry adhesive that will activate either by solvent or (always preferred) heat and pressure.
8. To protect metals that are subject to all weather conditions, industrial gases, corrosion and other forms of attacks.

You perhaps, want to know what the requirements are for each of these items. I will give my version based upon experience without going into much of the technical phases:

1. Gloss—A lacquer so formulated that it will impart to the surface of materials such as aluminum foil, paper and other like materials, maximum sheen. It must be plasticized to remain reasonably flexible, dry rapidly and not block when subjected to temperatures up to 140° F. In most cases, the coating must be free of odor when dry. There are many coatings in use, still I feel there is room for much desirable improvement. For example, the tendency of such lacquers is to deposit their solids content, dull or flat, when the solvents dry off. My humble attempts to improve gloss is expressed in a pet phrase—"Cellophane that won't come off." This is something to shoot at.

2. SLIP—A lacquer coating for web materials that will greatly reduce surface friction, thus adding to the efficiency of machinery tools working to fabricate such materials, such as folds and tucks into their final form. A slip lacquer (given this name) would find a ready market. Perhaps No. 1 could be combined with No. 2, providing economy can be practiced. There are in daily use thousands of pounds of plain laminated sheet materials that must pass through wrapping and folding machines that are subjected to what I call Tool Bite. An efficient slip coating will lubricate the surface for easy skidding: considerable waste of material can be saved by this type of treatment. This is worth shooting at!

3. Priming Surfaces—Aluminum foil, paper and board each initiate a distinctly different problem. Aluminum foil, due to rolling operation, contains on its surface, microscopic deposits of fatty acids. The foil is impervious and therefore non-absorbent, whereas to the contrary paper and board are not impervious and, therefore, absorbent. Aluminum foil is at times chemically washed or surface treated with a microscopic film of an organic compound used to form a foundation for anchorage of lacquer inks or coloring compounds. A thin transparent lacquer priming coat has possibilities that may prove the better method, especially if economical. Paper and Paper Board are prone to soak up lacquer, robbing the surface of its intended coat. Higher solids together with maximum drying speed may be the approach to bring lacquers into wider use for this type of material treatment.

4. Bonding—A lacquer adhesive such as I visualize does not exist as yet, ready for use—at least, I am unaware of it if it does. This lacquer bonding agent should be free of water, hence not a water emulsion. It must be capable of almost instantly sticking securely paper to aluminum foil, foil to foil, and foil to paper to foil. It must have attributes for application at high yardage speed, fast drying or setting, flexibility, odor free and age without deterioration. It must not delaminate when subjected to heat, representing temperatures up to 350°F. The adhesive must not string nor build up on fountain or offset applicator rolls. We have designed and built special machinery that is capable of providing means to handle an adhesive of this (what I will term) revolutionary type. The principal problems to solve are—First—firmness of set film when combined to avoid softness of finished composite sheet. Second—

Presented before the 60th Annual Convention of the NPV & LA at the Congress Hotel, Chicago, November 8, 1948.

fountain efficiency of application and, Third—resistance to softening by heat subsequently applied during fabrication that will avoid delamination. Perhaps many of you have formed the question—Why not use hot melts? The answer is the problem of heat delamination and high cost. Aluminum being impervious can receive the applied film of adhesive and before contacting paper or other material, the carrier solvent can be evaporated, leaving the plasticized solids tacky enough to bite and set when contacted. An important hint is to work on a hardening agent that will bolster the normal solids to give stiffness to the end product. We use a number of aqueous adhesives and while they do a good job, great care must be taken to control the moisture content which is critical in the end product. With my dream lacquer it would be fool-proof in this and many other respects. There are many very light weight web materials that can be materially strengthened by the solids of such adhesive, thus contributing to the overall economy of the end product.

5. Protection of Printing Inks—Lacquer Inks are used extensively in gravure printing and are delicately sensitive to scratches, scuffing and other defacements caused in handling and especially during machinery fabrication. Considerable progress has been gained in printing processes by applying an overcoat of lacquer to the printed sheet during the printing operation. The objective sought in using lacquer for this purpose is to have the following qualifications: maximum transparency to raise color value, maximum gloss, hard surface but flexible to withstand folding and non-thermoplastic to withstand direct heat contact up to 400°F. without softening or bleeding the inks. Must not have keen affinity for blending with inks. We met this challenge and have this lacquer in use performing this function on our new aluminum cigarette package, exhibited at this convention. Many millions of these packages have been manufactured and used with no lacquer failure. Incidentally, this overcoat lacquer firmly seals the inks no matter how much you punish the material through pocket use. Needless to say, it has no blocking tendencies.

6. As a Vehicle—Lacquer is a carrier for inks, coloring dyes and pigments. Reynolds Metals have done a lot of basic pioneering in this respect with the result of creating millions upon millions of dollars worth of new aluminum products that have been processed and still servicing an ever increasing demand. Aluminum foil combined with the use of lacquers has produced labels, wrappers, containers and packages that have contributed in no small way to the ever increasing sale of commodities. Aluminum and lacquer is a team doing a job as "The Silent Salesman," which means eye appeal and quality protection.

The job yet to be done is to improve color value and maintain it with age. The color compound must be such that it will not clog, by caking in the delicate screen cells of gravure printing cylinders. Remarkable work has been done in compounding and applying lacquers of gold and transparent colors to aluminum foil that is opening new horizons in the container and packaging industry.

7. Thermo-Plastic Adhesive—I like to visualize the perfect package that meets all requirements. My picture shows a package that is impervious to gaseous fluids, its exterior walls branded with lacquer transparent colors, overcoated with transparent lacquer, shining with gloss and sealed tightly with a thermo-plastic lacquer through the simple medium of applying heat and pressure to the seams and closures to activate the lacquer into a secure bond. Again I call attention to our new aluminum cigarette package. I have already described the function of overcoat lacquer and now we will see how important the heat-seal lacquer is to the efficiency of this package. The speed of fabricating, loading and sealing is 125 packs per minute. The machine cycle time for sealing provides only 2/6 of a second. Means had to be provided to stretch this time to three seconds without sacrifice of machine output. This was accomplished. Cigarettes are extremely sensitive to odor contamination, hence any residual solvents released during activation would cause trouble. While gravure printing the package material, the thermo-plastic is applied in a pattern design suitable for body seam and closures. This application is made by a specially designed cylinder containing etched cells that pick up the lacquer and deposit to the web sufficient body or density to form a secure bond. It must not block when the web material is tightly wound into rolls, imposing high compression, and when subjected to shipping and storage temperatures up to 140°F. The most interesting phase of this package is that two lacquers are used in its fabrication, each having to function in its own way. One is non-thermoplastic because it must resist softening when directly contacted with heat in excess of 400°F. and the other deposited upon it that must have such affinity for heat that it will activate over a flexible temperature range of 200° to 350°F. The combination of these two lacquers produces some chemical phenomena, a chemical seal that appears to neutralize migration of certain constituents. This I believe accounts for the non-blocking tendencies of the heat-seal compound. Solvent balances play a very important part during the laydown application. Colors of lacquer inks previously applied to the web must not be thrown off shade when contacted with its protective lacquer film. The sequence of time, mind you, from one stage to the next, is short seconds.

Referring again to the new aluminum cigarette packages, I know you will be interested in how much lacquer it would require when it becomes the national 20's pack for all brands. Last year 385 billion cigarettes were manufactured and this could represent 19 billion 500 million packages, each package contains 26 square inches of surface

or 507 billion square inches to coat. I have samples of this processed web material that is available for your inspection.

I designed heat sealed lacquer coated packages and the machinery for its fabrication about fifteen years ago. This work was truly pioneering. Lacquers for such purpose had to be formulated from scratch. I always believe I started ten years too soon because it required that much time for industry to build, to make available material supplies, to meet fabrication requiremnts. Commodity packers had to be sold on the idea of heat-sealed packages, then the consumer had to be sold. Today we are arriving with the know-how of what lacquers can do to expand the packaging industry into still a larger giant. I want to take this opportunity to pay tribute to a swell guy, a true friend and a genius consultant who has contributed in no small way to my humble efforts in this direction—Alex Wilson.

8. Protection of Metals—We are ever alert to find a lacquer coating material that will have the following top qualities:

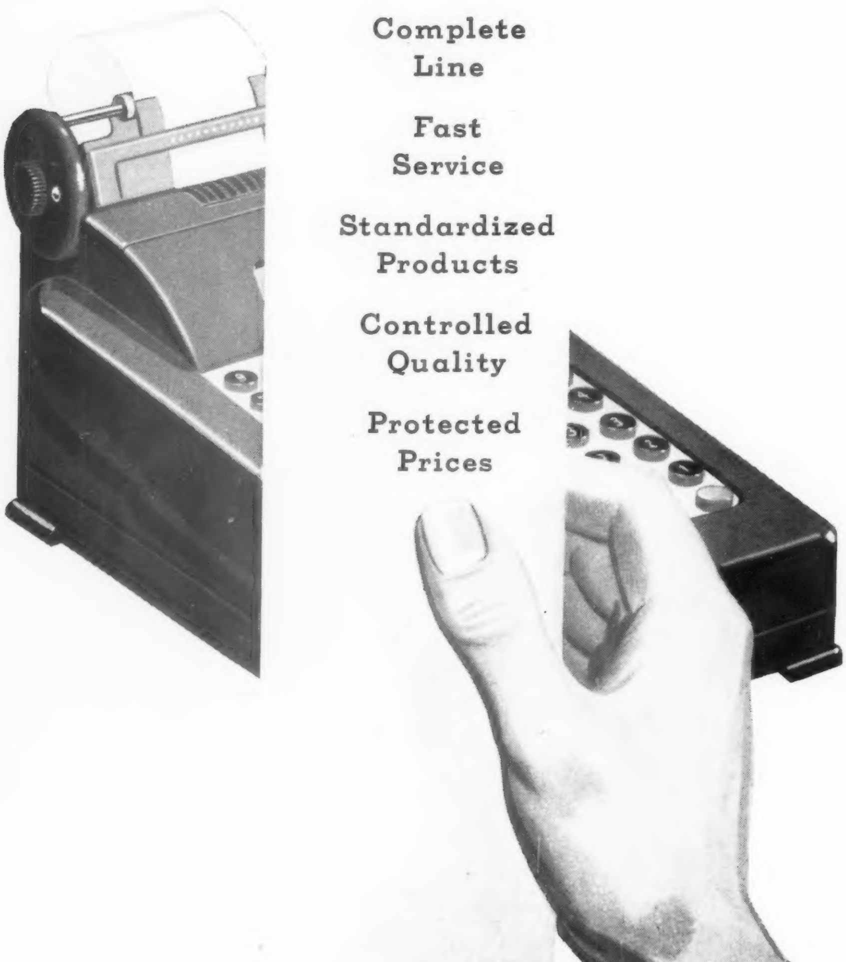
1. Adapted for application by spray or roller and when dry, have a hard surface, well anchored to the metal, resist scratching and not peel when subjected to deformation.
2. To resist all effects of variable weather conditions, industrial gases, chlorine gas, acids and oxidation.
3. To carry pigments and pastel color dyes without chalking.
4. Not discolor with age.
5. A primer over die drawn surfaces to lay a foundation for finishes that will not be marred by die drawing discoloration blemishes.
6. Be a stable compound, economical in cost.

Maybe this is the Utopia of Lacquer, but why not aim at it?

I have with me some small samples of sheet aluminum that have been sprayed with a new resin called Deveran. (Remember the Navy Plane.) It is a substantially chlorine free condensation polymer of Eppi-Chlore Hydrin and Bis-Phenol. After spraying it is baked for 20 minutes at 400°F. It has emerged from its embryo stage and is produced by a prominent manufacturer. We began investigating this most interesting material after I was given a moulded ball of the baked compound which I dropped out of a window thirty-five feet to a concrete pavement. It bounced back up into my hand, undamaged. Our experimental work with Deveran is encouraging as it shows promise for application to certain special aluminum parts. When aluminum sheet is drawn into shapes by dies, lubrication is necessary resulting in dark stains. The practice is to anodize these parts to restore a clean, pleasing finish.

Briefly, anodizing is an acid rinse using a solution composed essentially of a chromic-phosphoric acid mixture to remove alkalies, then followed by a cold water rinse; then etching in an alkaline solution which contains caustic at elevated temperature. This produces a uniform matte finish to

any way you figure...your



eradicate the marks described. This is followed by a cold water rinse again, then the anodizing bath which is electrolyte, a solution of sulphuric acid. The equipment requires a delivery of about 14,000 amperes. It requires many minutes to deposit a coating thickness of approximately 1/10 of a mil. Again a cold water rinse, then a hot water seal. The sulphuric acid electrolyte produces a porous and absorbent surface and the hot water seal will change the coating to aluminum monohydrate. The resultant, anodic coating, is aluminum oxide (AL_2O_3) and is next to diamonds on the MHO hardness scale. Incidentally, one of the chief uses for aluminum oxide is in the manufacture of abrasives.

We are ever alert to discover better methods of finishing. Recently we put into operation an alodizing process to prime aluminum surfaces for spray finishes. Alodizing is a chemical treatment to prepare surfaces for painting, an alkaline cleaner designed to remove oils, greases and foreign materials, a cold water rinse to remove the alkaline cleaner so that it will not interfere with subsequent operations. Then the alodine treatment that is believed to be a chromate substance which is supposed to be inert to any further reaction. This treatment produces a green tint, but very faint. Attempts to subject the aluminum to more time in this solution in order to obtain a denser body color in the green shade, results in powdering, so the time factor is quite critical during this stage of operation. This is followed again by a cold water rinse to render the surface free of the alodine bath material, and the final step is a deoxylyte rinse, an acidulated solution, and its chief purpose is to leave this surface slightly acid, which incidentally, we find is best for paint application. The aluminum so treated must pass through an electrically heated drier which dries the surface for subsequent painting. This process shows the trend towards what I hope will be an all out lacquering process. The part to be finished will be solvent washed to remove grease then sprayed with a lacquer, treated with aluminum paste, to form a primer coat so pigmented to cover working defacements, then after a few seconds of flashing, spraying a clear lacquer over the pigmented coat to complete the finish.

Aluminum pigments, as you know, are classified into many types. A carefully selected grade of aluminum paste was mixed into a clear lacquer and experimented with to have just the right amount of paste that would by one application completely cover die drawn surfaces to mask out all traces of surface defacement and produce a hard, glossy finish. The lacquer used required baking at relatively high temperature. When the parts were cooled to room temperature, the aluminum particles of the paste begin migrating to the surface, leaving a chalky finish. We obviated this difficulty to some extent by repeating the operations of spraying with the aluminum pigmented lacquer immediately followed while in the wet stage by spraying a transparent lacquer.

There is an opportunity for research to develop a clear lacquer that will carry the aluminum paste where the aluminum particles will not migrate to the surface. The aim is to homogenize the mixture. We have on exhibit in our New York Office reception room, one of our aluminum boats that was finished in accordance with this procedure, and it may be interesting to you when you are in New York to pay us a visit and inspect the finish. It will at least show you what the opportunities are for new finishes.

Our experiments were carried on under some handicap inasmuch as, at the time, our only equipment available for baking was infra-red lamp tunnels and we observed that in deformed shapes, such as the boat, for example, the heat rays could not penetrate the cavity formations, hence the curing was not uniform. We have since installed a large convex drying oven, which greatly improves baking operations. Air drying is much to be desired, but certain resins when baked produce a stronger surface to resist abrasion. Mr. R. S. Reynolds had the foresight and courage to build many thousands of sets of dies to prove the almost endless use to which aluminum may be adapted. Vast new equipment has been installed for the most modern means for applying coatings. Millions of pounds of aluminum building materials are being processed through this equipment to emerge with finishes unknown even a short time ago. For example, one of these products is aluminum siding for the building trade that is white on surfaces embossed to add remarkable strength and give the new look. Painted aluminum, please note: Much work is yet to be done to process large quantities of pieces that will all have the same shade or color value when assembled into final construction form, for example, a wall or roof.

The can industry and packers are already cognizant of increased sales of commodity brands due to display appeal enhanced by use of color lacquered aluminum foil labels. I have a few representative samples to show this new art for stimulating sales.

We are entering the can field with aluminum. A can one-third the weight of steel, having its body seam formed with thermo-plastic adhesive instead of the conventional body interlocked and soldered type. Again aluminum sheet and aluminum foil in combination with lacquers open up a new horizon for this industry. Since there is always a lucrative market for aluminum scrap, aluminum cans will offer premium salvage returns.

We are living in such an exciting age and aluminum is in tune with it, so full of interest and opportunity to create, to improve upon what has already been accomplished. My subject concluded, I want to leave with you my understanding of the powerful word attention: to keep one's attention always upon the constructive side of life is to cooperate with life's evolution. We are individuals, given free will with which no other form

of life is so endowed. Our individuality therefore means we are gods in embryo. Each one of us has a job to do that no one else can do. Where one's attention is, there that one is. If the attention is upon that which is constructive then we are properly tuned in to receive what we are looking for. It may be information we are seeking and if the feelings are harmonious and the will or, I should say, the desire is intense enough, you cannot be denied the fulfillment of your desire. Your attention is your life force and it goes forth to feed whatever it is focused upon. Believe me, the tragedy of our time is that many people through selfishness fasten their attention to negative things and become so much a part of it that they find themselves engulfed and helpless, and the worst crime they unwittingly commit is the feeding of their power into dissipation, hence becoming slaves to the things they do not want.

Everything constructive that we can possibly conceive of is already perfected in our world ready to come forth into visible manifestation at our call, but our tuning in apparatus, which is our attention, must be correctly set without wavering. Those who discover anything new did a good job in focusing their perception and receptivity by the quality of their attention.

I try hard never to criticize my fellow men because in doing so I criticize the very source of love pouring out to beat men's hearts without which we could not exist. Love is the great cohesive power that keeps our earth moving in its orderly orbit. This earth is in its process of evolution and to do its job light must radiate out into space to cooperate with other planets. This light can only be given out by the individuals of this earth. No other way can it go forth. Feelings of love for your fellow men, intense enough, will unlock the light, God's great blessing to all mankind.

We will look forward to continued improvements in lacquers as well as new discoveries that your able and alert minds will bring forth.

TECHNOLOGY

PROCESSES FOR MODIFYING ROSIN. Rosin can be modified by two fundamentally different methods, which usually are combined to get the best results. These methods are based on neutralization of the carboxyl group and reaction with the unsaturated part of the rosin molecule. The products are used as a filler to improve gloss and hardness of the paint or varnish film. They are easily soluble in the common solvents and the harder types promote drying. Depending upon the method of treatment, they are more or less liable to oxidation. The molecular weight increases most for the phenolic- and maleic-modified ester gums and especially when esterified with pentaerythritol. J. Rinse. J. Polymer Sci. 3, 371-5 (1948).

A COMMENTARY ON INDUSTRIAL RESEARCH*

By ARTHUR MINICH, Nuodex Products Co., Inc.

There is hardly a phase of modern industry that has received more widespread publicity than industrial research. Generally speaking, the American public, by way of advertising and profuse but superficial articles, has become conscious of the presence of research departments and research activities within industry.

Corresponding to the increased awareness of research in industry there has been a fairly rapid growth in the volume of research in America. It is estimated that during 1947, the total of government and private research expenditures will be no less than about $1,200,000,000—this is truly a very impressive figure. This compares with a total of only $345,000,000 in 1940. Thus on a dollar basis the growth has been three-fold. In terms of total personnel the growth has been from approximately 78,000 in 1940 to about 135,000 during 1947. Of these total figures of personnel approximately 40% are chemists and engineers.

Yet the pursuit of research by industry is not an entirely clear and well defined activity. Management may be far more definite about optimum production methods, for example, than about conditions favoring the best output of research departments. It may be well, therefore, to discuss the functioning of research within industry and to define certain principles upon which research executives can agree. Let us admit that there are a number of elements of industrial research administration where the research directors have sharply divergent opinions.

What Is Industrial Research?

The dictionary definition of "research" sets forth that it is a "systematic investigation of some phenomenon by the experimental method." Therefore, we may say that a research department of an industry or of a plant is the department where systematic inquiries in phenomena are undertaken and that the theories that may be arrived at are usually verified by the experimental method.

While it can be thus assumed that the primary intent of the research department is to establish facts, it is of course, equally true that in the average industrial set-up the findings, in order to justify the existence of the research department, should not only be valid and correct technically, but must also be pertinent to the business interests. This differentiates industrial research from university or academic research.

A good summation of the broad objectives of industrial research has been stated by David B. Hertz: "An industry should turn to research when it wishes to accomplish one or more of the following things:

1. Anticipate and prevent troubles.
2. Cure existing troubles or nuisances.
3. Reduce the cost of a product.
4. Increase the utility of a product through modification or simply by finding new uses.
5. Reduce the consumer's operating or maintenance cost.
6. Develop new process material or products.
7. Improve the quality of existing materials or products.
9. Amass technical information leading to a better understanding of a product.
10. Contribute to the common store of general knowledge with the ultimate motive of increased markets through raised standards of living.

It must be granted that in very large organizations research may include more "luxury tangents" than in the rank and file of American industry. In the giant organizations of American industry there are adequate funds available to permit a considerable number of research workers to engage in very protracted research, some of which may be entirely unrelated to the business of the corporation. In general, the research department of an industrial organization has to contribute facts which should ultimately benefit the commercial interests of the concern. Within this overall specification it will be inevitable that a great deal of research work will at best only establish negative facts, but this, of course, cannot be helped. Research of an industrial laboratory must be judged by management in terms of over-all output and it is obvious that not every project undertaken will come to a favorable end.

One of the questions that is frequently asked is the cost of research. Broadly speaking, American industry spends approximately two cents of each sales dollar received upon research, but this very general figure is subject to wide fluctuations.

Research Head Should Be Part of Management

It goes without saying that a research department, in order to justify its cost to management, should be properly set up so that optimum results may be expected. The head of the research department should preferably be a man who is part of management itself. Only through such rank can the research director do the best possible job for his co-workers, his department and his company. Nowadays this is recognized so that in many of the progressive companies the research director occupies the position of vice-president and thus sits in on management meetings. It is also a fact that the workers within the research

* An address to the May Meeting of the Kansas City Paint and Varnish Production Club.

department have greater faith in management's recognition of their particular accomplishments when their leader is a part of management.

The qualifications, then, of a research department manager must be such that he will not only be a competent administrator of his research department, but he will also have to possess the ability of partaking in the over-all functions of company management. This will involve, in addition to the necessary prerequisites of professional ability, also those qualifications of tact, diplomacy, perseverance, which may be grouped under the term of "business personality."

The professional qualifications of the research director are, of course, important but they do not equal the need of excellent leadership and managerial ability. As a matter of fact, in some research departments the managers are business men without much technical training. The role of the research director in encouraging the best that lies in his chemists' minds to come to fruition is far more valuable to his company than his own particular proficiency in chemistry or the other sciences.

Team Work Important in Modern Research

The technical director of one of the large chemical companies stated that it is not the function of the research director to direct but rather it is his responsibility to encourage the researchers to perform with minimum direction. Irvine H. Schell of Massachusetts Institute of Technology, in his book entitled "The Technique of Executive Control," quoted Edward D. Jones as defining the executive's job as that of providing in a group of men "harmony of mood, harmony of attitude, or the desire of all to accomplish the same thing." The definition would apply particularly well to research directors.

Certainly it is fairly well accepted now that for best results the researchers should be given ample latitude and should not operate on any given project within narrow lanes prescribed by the superiors. From this it follows, then, that the quality and caliber of the researchers is very important. A research department cannot be successful if the director exercises a "monopoly on brains," but on the contrary the professional caliber of each and every one in the research department contributes to the ultimate output and quality of research.

Therefore, chemical concerns with successful research departments carefully screen out applicants for research positions. The large organizations are able to send "talent scouts" to the prominent colleges where they interview men in the upper ten of classes before graduation. This technique is, of course, one that the smaller organizations cannot afford and it may put them at somewhat of a handicap. In determining acceptability of a candidate some of the chemical organizations consider very carefully, in addition to the professional aptitudes of the candidate, his total personality picture. There is increased recognition that a research department must rely on well formers, so it is not surprising that screening integrated team-work rather than on star per-candidates for ability to work with others, to play with others, and generally to be team-work-

ers, is considered a "must" in addition to professional talent.

Factors in Technical Personnel Selection

Dr. C. O. Tongberg enumerates the four most important criteria for evaluating a technical man for industrial research as follows:

1. Mental capacity.
2. Technical education.
3. Technical ability.
4. Personality and character.

The first three factors are relatively easy of ascertainment; the fourth is unfortunately quite intangible. To cite a few of the many facets that make up personality and character—integrity, ability to get things done, good judgment and common sense, tenacity of purpose on any given problem, versatility and ability to coordinate all phases of the problem that confronts him, an objective point of view, etc.

In order to attract and hold good professional men it is necessary to provide them, in addition to salaries of proper and competitive levels, with working conditions that will appeal to their professional interests. Surveys conducted by several professional associations have definitely established that salary by itself is not the major factor in a chemist's like or dislike for his position. The modern trend is in recognizing that the research director's job is not to direct as much as to encourage creative thinking on the part of his researchers. This is an important element of a satisfying environment for research men. To this must be added an enlightened policy on publications. Professional men like to have the opportunity of communicating to their fellow scientists their findings by way of publications in the respective technical journals. This must be tempered sometimes by the company's necessity for keeping secret certain data such as may develop when patent applications are being made, etc.

How to Hold Professional Workers

As far as patents are concerned, there should be strict adherence on the part of research management to the patent law requiring that the patentee is "he who has invented." Thus, the man or team having done the original creative thinking should be rewarded with the patent. Some companies have developed certain special bonus rewards which are equally distributed to the total membership of the research department. By the way, it has not been found very satisfactory to grant special patent bonus awards to the inventors because that might set up a barrier of secrecy between the various teams and men within a research department.

There should also be a recognition on the part of management that professional men should be given the opportunity of attendance at scientific and technical meetings. The research men should be encouraged in seeking the association and exchange of ideas with other technical men, for by nature the typical research worker is a bit on the introspective side.

Working conditions are also very significant. The present-day professional man likes to work in surroundings that are pleasant, sanitary and efficient. The large manufacturing concerns have found it good practice to geographically remove research laboratories from factories so that noise, dirt and other nuisances are minimized.

An important adjunct to quality of working conditions should be the library. Some years ago only the very large concerns deemed it worth while to maintain libraries within the research departments, but there seems to be an increasingly better understanding of the very useful role of a library as adjunct to the research laboratories. In the large research laboratories the facilities available to the researchers are, as one might expect, broader than is the case with the average size department. They may include such facilities as well-equipped machine shops, separate purchasing departments, glass blowers, etc.

Sufficient attention must also be paid to the problem of advancement opportunities. Professional workers, if they are qualified for advancement, should be granted such opportunities. This is not necessarily done by means of salary adjustments, although this too should be done—equally satisfactory to the professional man is a promotion in regard to the project that he is entrusted with. The scope of the project should be usually commensurate with the capacity of the man and wherever possible projects may be tackled by teams, the head of which would be the senior.

I have attempted in the foregoing to enumerate the factors totaling up to an environment which will encourage good professional men to become associated with a research organization and to remain with it.

Top Management Should Select Research Projects

This personnel—the team—represents the most important "equipment" of any research department. The public has been led to believe that a research department is a place where magnificent and mysterious equipment is employed, where magic reactions take place. The truth of the matter is that the only equipment that a good research department finds absolutely indispensable is a well-integrated and professionally competent staff.

With the best technical staff in the world, management would still not obtain recompense for its investment if the researchers are not engaged in projects of potentially commercial value to the company. It would be expecting too much from the research manager's business acumen to burden him with the sole responsibility of selecting projects. That should be the responsibility of total management.

In the operations of the company with which the writer is associated, research projects are usually the result of group thinking on the part of top management. Even when this course is taken there is still some factor of business gamble in research—often a good product will not be practical

because, unexpectedly, the public or the prospective users are indifferent to it. Sometimes market conditions may change so rapidly that by the time the project is completed the initial pertinency has vaporized. It is possible to minimize the hazard through management selection of research projects. Unquestionably, where research projects are initiated without the benefits of total management thinking, the risk of selecting projects which are potentially valueless to the company is very much increased.

In considering projects there should be no hesitation in soliciting the suggestions of everyone in the research department. In the writer's organization a file "Future Laboratory Projects" is maintained for this purpose and everyone is encouraged to submit ideas. This gives everyone in the research department the opportunity of recommending major projects—but management must reserve the right of selection.

Dividing the Researcher's Time

The foregoing should not be interpreted as meaning that the research man's entire time is taken up by authorized projects for this has been found to be unsatisfactory to the professional workers. A number of organizations have found a happy compromise by dividing the researcher's time approximately in the ratio of 70-80% on authorized projects and 20-30% on his own projects.

After the project is initiated and authorized the research director will set it in motion. This is preferably done by means of thorough discussions — an extra hour spent in an initial discussion of basic objectives will often save days or weeks or months in the successful completion of the project.

During these initial meetings the progressive research director will very carefully point out to his co-workers the commercial objectives because usually technical men are not too clear and sound on what the commercial demands and expectations may be — the criticism is often made that researchers sit in ivory towers. The business perspective involved in clarifying a research project must be essentially communicated to the researchers by the research director who will originally have gained this understanding by being a member of management.

The research director should not straightjacket his men's course of action. As stated above, he should take pains in setting the objectives but should not waste time in steering them in narrow channels as far as their accomplishment of the objectives is concerned. If the research director exercised good judgment in building a good staff, it will not be necessary for him, nor even advisable, to direct the work of the reseachers in detail —they generally know what to do once clear objectives have been furnished them. I am happy to state that from what I have been able to learn, the old "cook book" technique of directing chemists is rapidly disappearing.

Necessity for Progress Reports

Once the project has been conveyed to the re-

searcher who may be working on it singly or who may head up a team (often two to five men), the progress of the investigation should be measured by reports. These should be verbal but complemented by brief progress reports. It is the very nature of research that those engaged in it are usually dealing in the realm of the unknown, so that one cannot predict what trend the investigation might take. Often a project that seems in its original conception to be one that could be readily explored, may prove after the beginning of the investigation to represent a large undertaking.

Close contact between the director and his staff will bring to light such unexpected changes and often a project may be cancelled or modified at the first progress discussion. It is hardly necessary to say that such alertness may save management very handsomely, and it is equally true that often the unforeseen results of the first phase of the search might suggest the selection of entirely new fields in place of the originally selected one.

Written reports serve as the vehicle of relaying the researcher's first-hand experiences to his research director and others in the organization, and from this it follows that reports form a very necessary part of the research man's endeavors.

This brings up a serious weakness of many workers in research laboratories. Chemists have earned justly a reputation for being poor hands at reporting upon their accomplishments. Some time ago one of the leading technical journals conducted a survey among management of chemical industries asking them what efficiency among chemists was most needy of remedy. The majority replied that chemists generally did not exercise the best command over the English language and that their reports were, on the average, below the quality of their work. Now, it seems perfectly obvious that the best research job that is not crystallized in a soundly constructed and well executed report is usually wasted and will not result in ultimate benefits to the company. The director should devote time to this factor and should forever instill in his men the appreciation of the need for good reporting.

What Written Reports Accomplish

This subject, I believe, is deserving of sufficient attention and I would like to quote here from an article on this subject written by Florence E. Wall, "Why Write Reports?"

"A report is simply a statement of facts and conclusions, intended for some specific purpose. Much as an earnest research worker occasionally resents having to take time from laboratory work to write a report, the requirement to do so is definitely productive of benefit because:

1. Co-workers, group leaders, and directors of research are under obligation to keep the management of a company or the clients of a consulting laboratory in constant touch with the progress of their respective investigations;

2. The work of assembling the data and organizing a presentation of the results of his research helps the chemist to objectify and evaluate what has been done and to organize his own thoughts and his program;

3. The research worker has an opportunity to show what he can do and how he does it—not only his knowledge of the facts and his mastery of methods, but also his ability to interpret what he has learned and to import his knowledge to others;

4. Patentable products and processes are thus brought to the attention of the proper offices as early as possible. Reports constitute valuable documents in establishing the dates of conception and reduction to practice."

The project having culminated in a proper report concerning the work and having usually appended thereto the director's qualifying remarks and interpretations, will now be ready for submission by the research director to management. At this point the responsibility of research does not cease. Often, as in the case of creation of a new or greatly improved compound, the next step will be to put the compound through the pilot plant. This operation may be associated with the research department, or it may be a part of the manufacturing facilities, and in the latter case it would be under the direction of the production manager.

Close Contact with Sales Department Needed

Assuming that the product emerges from the pilot plant production as a very close relative to the specimen of the research laboratories, it will then be ordinarly ready for market research. This department may sometimes be functioning as an adjunct to the research organization, but more often it will be the "feelers" and "antennas" of the sales department. Through the research director's participation in management meetings, and even more important through close teamwork with the sales head, a close picture will be acquired by him as to the commercial acceptance of the product and the difficulties it might possess from the business point of view.

It is extremely beneficial to management if research and sales are joined closely together during this phase of the product's slow emergence from an investment to an asset. Usually the product, when given the acid test of market utility, will evidence certain flaws and defects, and all-in-all will be far from a finished product. Rare indeed does the result of chemical research emerge in final and practical form without first "getting a beating"; but all this slow tortuous procession of development should not discourage those who are investing in chemical research. The truism "nothing ventured nothing gained" applies most forcibly to chemical research. There can be no better insurance for continued business success than to create and maintain a well organized research department.

But the services of industrial research go far beyond those direct benefits accruing to the respective industrial organization sponsoring it. The results of research investigations are generally publicized so that apart from patent restrictions

the whole industry will often benefit from the knowledge gained. We may still go beyond this definition and state that sometimes entirely new industries spring up as a result of research investigations, and frequently also the research carried on in one industry may directly and indirectly influence and benefit other industries.

It is no exaggeration to say that today's frontiers of industry and science and civilization generally can be extended without limits through the application of research, of which industrial research forms such an integral and productive part.

Addenda

For those who might be interested in literature on the subject of industrial research I would recommend the following:

The Parts Played by Management and the Technologist in Making Research and Development Work Effective — by Norman A. Shepard, Chemical Director, American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y.

How Can We Build Better Teamwork Within Our Research Organizations? — by Norman A. Shepard, Chemical Director, American Cyanamid Company, New York, N. Y.

The Essentials of a Good Report—by Florence E. Wall, Technical Editor. Evans Research and Development Corp., 250 East 43rd Street, New York 17, N. Y.

Specifications for a Good Research Report — by Dr. Johan Bjorksten, Research Laboratories, Chicago, Illinois.

Selling Industrial Research to Management — by D. E. Chambers, Executive Engineer, Research Laboratory, General Electric Company.

A Practical Approach to the Employment of Technical Personnel—by C. O. Tongberg, Assistant Director, Research Division, Standard Oil Development Company.

Management's Role in Planning Research—by David B. Hertz, Assistant Chief Development Engineer, Celanese Corp. of America, New York, N. Y.

NEWS AND REVIEWS

A revised edition of a technical booklet on Parlon, Hercules Powder Company's chlorinated rubber, now is available. The revised edition contains considerable new information on the use of Parlon in protective coatings, printing inks, paper coatings, textile finishes, and many other applications.

Parlon is an excellent fortifier for long-to-medium oil length alkyd enamels. The addition of Parlon gives a faster drying time, and in the case of force-dried or baked enamels, develop harder films which may be handled sooner.

Charts showing how Parlon speeds the drying time of enamels, and photographs illustrating the results of drying-time tests are included in the new booklet.

RECENT ADVANCES IN PAINT TECHNOLOGY

SURFACE FORCES AND SOME OF THEIR APPLICATIONS. The classical theory of capillarity is discussed and stated to be insufficient to explain in a satisfactory manner the phenomena of wetting and spreading. A schematic view of the theory of the fields of surface and interfacial forces is presented, and the application of this knowledge to paints and varnishes is discussed. R. Morlock. Peintures Pigments-Vernis **24**, 179-182 (1948).

TITANIUM ENAMELS. The special process required for the production of enamels containing titanium dioxide as opacifying agent is reviewed, and the nature of these enamels (color, whiteness, decreased enamel weight, flexibility and thermal shock is discussed. Behavior of the enamels such as chipping vs. enamel thickness, cover coat application weight vs. deflection to produce failure, impact resistance vs. metal thickness and magnitude of bottom radius are illustrated by graphs. 16 references. B. W. King. Steel **122**., No. 125, 108, 111, 128, 130 (June 21, 1948).

STYRENE COPOLYMER PAINTS. The development of styrene copolymers for paints is traced to the discovery of the styrene-drying oil copolymers. The reaction mechanism, reaction unit and process are described, as practiced at the plant of Lewis Berger & Sons, Ltd. Anon. Industrial Chemist, May, 1948, 307-310.

POLYTHENE FOR PLATING. The nature of polythene and its application by flame spraying are briefly reviewed, and the chemical properties of polythene in the presence of various inorganic acids, alkalies and solvents are tabulated. The technique of preparing metal surfaces before coating with polythene, the lining of plating vats and coating of plating jigs is described. While polythene is said to be excellent as a marking agent in electroplating, the author does not advise its use in vapor degreasing equipment. P. G. Clements. Electroplating **1**, 302-308 (1948).

A RAPID METHOD FOR DETERMINATION OF COBALT IN DRIERS. A method for the colorometric determination of cobalt, based on the use of ammonium thiocyanate in Cellosolve (ethylene glycol monoethyl ether). The procedure, preparation of solutions, calculations of results, interference by other metals, and other applications are discussed. H. W. Chatfield and H. H. Topper. J. Oil & Colour Chemists' Assoc. **31**, 125-133 (1948).

THE HERCULES HIGH-SHEAR VISCOMETER. High solids pigment suspensions are frequently applied industrially under conditions which subject them to high rates of shear. Since these suspensions, in general, possess complex flow characteristics, prediction of their performance under such conditions from conventional viscosity measurements is difficult. To assist in the accumulation of data useful in analyzing the rheology of complex materials under conditions of high shear, an inexpensive, precision viscometer has been devised. The construction of this viscometer, together with the rheological properties likely to occur in complex fluid systems and some of the mathematical treatments involved in their analysis is discussed. J. W. Smith & P. D. Applegate. Paper Trade J. **126**, No. 23, 60-6 (June 3, 1948).

THE ELECTRON TRAP MECHANISM OF LUMINESCENCE IN SULFIDE AND SILICATE PHOSPHORS. Phosphorescence and thermoluminescence emission from photoconducting impurity activated phosphors have been satisfactorily explained by the storage of electrons, freed from luminescence centers or other atoms of the solid, in metastable energy levels known as electron traps. Electrons escaping from these traps give rise to emission when they recombine with luminescence centers but there is a probability that they may be retrapped in empty electron traps before their final recombination with centers. The present theoretical and experimental studies attempt to determine the extent to which retrapping does occur and what effects it will have in modifying the phosphorescence and thermoluminescence characteristics. Theoretical treatment shows that there are marked differences in these characteristics for conditions when the retrapping process is present and for those when it is negligible. Experimental investigations of the characteristics of specimens of zinc sulfide, zinc silicate and strontium silicate phosphors indicate that, except under special conditions, retrapping of electrons is negligible. These results together with other work can be explained theoretically if it is assumed that electron traps operative in the luminescence process are spatially associated with the immediate neighborhood of the luminescence centers formed by activating impurities. This new concept is also supported by the relations found between the luminescence characteristics and the dielectric changes in phosphors of the zinc sulfide type. G. J. Garlick & A. F. Gibson. Proc. Phys. Soc. **60**, (6), 574-90 (1948).

PLASTICS FOR CORROSION CONTROL. Cellulose plastic wrappings have given good service as pipe coverings, but are not sufficiently resistant to corrosion for general application. Polyvinyl alcohol is resistant to organic solvents, but is limited in application by its solubility in water. Acrylic resins (Lucite) have found extensive use in electroplating tanks, plating barrels, etc., but their chemical and physical properties limit their use for corrosion control. Vinylidene chloride (Saran) has been used for pipe for handling chemicals. These resins can be used as coating materials in the form of emulsions, but may pro-

duce slight amounts of hydrochloric acid, sometimes causing metal corrosion. Vinyl chloride resins are applied (as coatings) in dispersion form and then fused into continuous films at about 350° F. These coatings are widely used in the electroplating industry; as compared with the vinylidene chloride coatings, these films are somewhat more stable and easier to apply, but are not as resistant to chemical attack. Nylon coatings are applied from solutions in alcohol and water, or of certain phenols (including cresylic acid), but the more chemically resistant forms of nylon are not generally recommended for coatings for the production of films. Nylon films are useful

for a variety of chemicals other than mineral acids. Polythene (polyethylene) films can be applied from hot chlorinated hydrocarbon solutions, or by flame-spraying, but difficulty has been encountered in securing satisfactory films by the latter method. A method has been developed for applying polythene sheets for tank lining. Only a very few chemicals have any effect on polythene except the chlorinated hydrocarbons and a few other hydrocarbons. Over a long period of time, oils and greases may swell polythene somewhat. Acetic acid appears to penetrate polythene films. No plasticizer is required for polythene films. Polythene has extremely high impact strength and outstanding electrical properties. Teflon (a polymer of tetrafluoroethylene) is outstanding in chemical resistance for packings, gaskets, pipes, fittings, etc. The only chemicals known to attack Tiflon are molten alkali metals and free fluorine gas at 300° F. It can be molded and extruded, but it is not soluble and cannot be cemented by any means yet discovered. A suspensoid-type coating is being developed. J. W. Shackleton. Corrosion **4**, 172-8 (1948) (abstr. through Chem. Abs. **42**, 4791-2 (1948)).